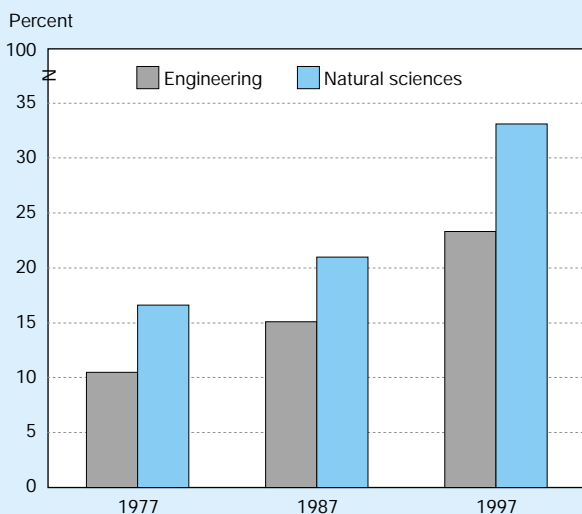


Figure 4-24.

**Japanese students entering graduate school directly after completing bachelor of science degrees**



SOURCE: Government of Japan, Ministry of Education, Science, and Culture (Monbusho), *Monbusho Survey of Education, 1998* (Tokyo: annual series). *Science & Engineering Indicators – 2000*

## Diversity Patterns in S&E Enrollment and Degrees in the United States

The Steelman report recommended full utilization of human resources for science but did not explicitly address issues of equity for women and minorities entering S&E fields. As these groups now make up the majority of the labor force, their equal entry into S&E fields is of current national interest.

### Enrollment in Undergraduate Programs, by Race/Ethnicity and Sex

Beginning in 1984 and lasting almost a decade, undergraduate enrollment in U.S. institutions of higher education showed strong growth, peaking in 1992 with nearly 12.7 million students. Undergraduate enrollment declined slightly each year until 1995 and leveled off in 1996. The decline is mainly from the decrease in the college-age cohort of the majority (white) population. White enrollment in undergraduate education leveled off in the early 1990s and has declined each year since 1992 for males and females, while enrollment for all minority groups increased. (See appendix table 4-32.)

This trend of increasing enrollment in undergraduate programs by underrepresented minorities has persisted over a decade. Black enrollment increased 3 percent annually from 1.1 million in 1990 to 1.4 million in 1996. Black males have had more modest gains than black females. In the same period, Hispanic enrollment in higher education increased at an even faster rate (7.7 percent) annually. The strongest growth, however, has been among Asians/Pacific Islanders (8.0 per-

cent annually). Undergraduate enrollment of foreign students grew very modestly in the past two decades; in 1996, foreign students still represented only 2 percent of total undergraduate enrollment. (See appendix table 4-32.)

### Enrollment in Engineering, by Race/Ethnicity and Sex

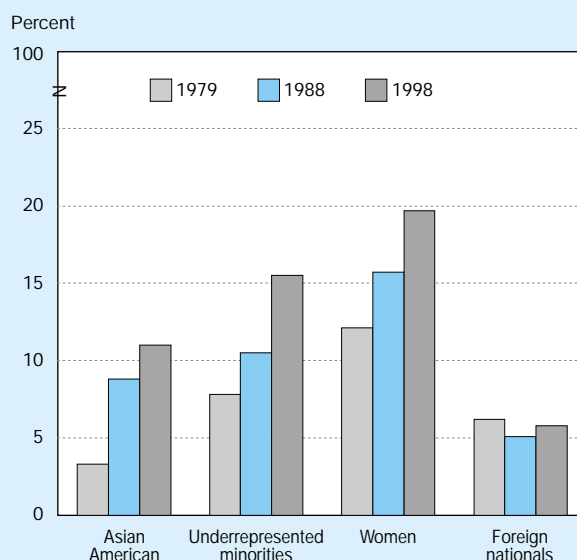
While total undergraduate engineering enrollment declined from 1983 to 1996, underrepresented minorities continually increased their enrollment during this period, and female students increased from 1987 to 1998. Female students enrolled in engineering increased from 60,000 in 1987 to 72,000 in 1998. For underrepresented minorities, the increases were greater over a longer period, from 37,000 in 1983 to almost 57,000 in 1998. (See appendix table 4-33.) By 1998, female students represented 19.7 percent of total undergraduate engineering enrollment, and underrepresented minorities represented 15.5 percent of such enrollment. (See figure 4-25.)

### Persistence Toward a Bachelor's Degree, by Sex and Race/Ethnicity

There is a considerable gap between enrollment in S&E programs and successful completion of S&E degrees. National longitudinal data with high school and college transcripts provide some indicators of retention in S&E fields, as well as students' exploration and switching to other academic departments in undergraduate education. The Beginning Postsecondary Students (BPS) Longitudinal Study analyzed

Figure 4-25.

**Representation of women and minorities in undergraduate engineering enrollment**



See appendix table 4-33. *Science & Engineering Indicators – 2000*

completion rates of all beginning students in college, including nontraditional (older) students as well as traditional students (NCES 1996). The analysis on completion rates presented in *Women and Men of the Engineering Path* was restricted to engineering students who had reached the threshold of completing three required engineering courses (USDE 1998). Based on these national surveys, this section provides summary findings on differences in completion rates by race and sex.

Persistence in S&E majors of beginning college students can be examined, by race/ethnicity and sex, through the BPS of 1989/90 and 1995 follow-up. The transcripts of a subsample of 926 students who enrolled in S&E programs their freshman year were examined over the next five years to identify the following outcomes: the proportion that completed a degree in an S&E field, those who still persisted in studying toward such a degree, students who switched to non-S&E fields, and those who dropped out of college. These data showed that less than one-half of the students intending an S&E major from any racial/ethnic group completed an undergraduate S&E degree within five years.<sup>16</sup> Further, females were more likely than males to complete an S&E degree within five years. In addition, about 22 percent of students from all racial/ethnic groups dropped out of college within five years.

<sup>16</sup>The completion rate is somewhat higher for all fields of study, not just S&E fields. Among beginning students seeking bachelor's degrees in 1989/90, 57 percent of those who began in four-year institutions completed a bachelor's degree in five years (see NCES 1996 for completion rates by enrollment status).

Besides completions and dropouts, the study further showed the considerable percentage of students (16 percent to 27 percent) who persist in studying S&E fields five years after entering and the percentage who have explored and switched to other fields. The study found that, compared with the white and Asian/Pacific Islander groups, fewer underrepresented minority students completed an S&E degree within five years, but a higher percentage were still persisting in studying for an S&E degree. In addition, a higher percentage of underrepresented minority students switched to non-S&E fields. (See figure 4-26.)

An analysis of persistence in engineering reported in *Women and Men of the Engineering Path*<sup>17</sup> found that, of those students who reached the threshold of the engineering path (had completed three required engineering courses),<sup>18</sup> 59 percent earned a bachelor's degree in engineering by age 30. The analysis used an 11-year transcript history 1982–93 of the High School and Beyond/Sophomore Cohort Longitudinal Study.<sup>19</sup> The study found that women have a 20-percentage-point gap in their completion rate of undergraduate engineering programs: a 62-percent completion rate for males and 42 percent for females (USDE 1998).

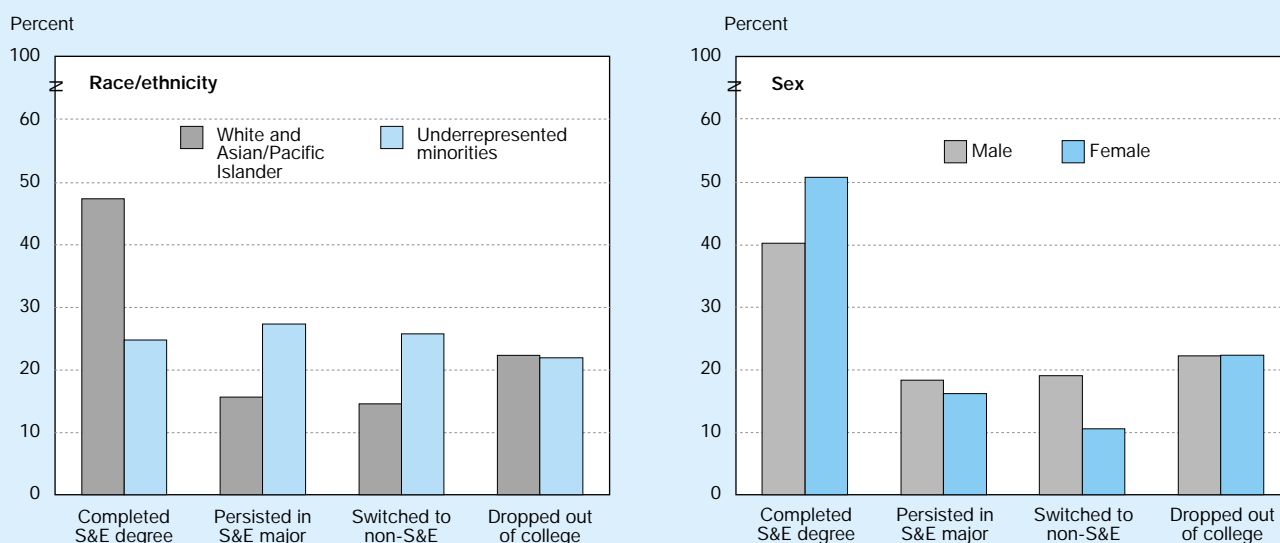
<sup>17</sup>See the full study (USDE 1998) for the contents of the engineering core curriculum, secondary school background characteristics of those who reach the threshold, the "curricular momentum" of mathematics and science courses in high school and college for those who enter and complete engineering degrees, various institutional attendance patterns, field migration, classroom environments, and the role of community college.

<sup>18</sup>Approximately 9 percent of all freshmen reach the threshold of the engineering path.

<sup>19</sup>The study used a representative sample of more than 8,000 students.

Figure 4-26.

**Completion and attrition rates five years after beginning an S&E major, by race/ethnicity and sex**



SOURCE: National Center for Educational Statistics (NCES), Beginning Postsecondary Student (BPS) Longitudinal Study (Washington, DC: 1996). (Based on subsample of 926 first-year S&E students in 1990 and 1995 follow-up.)

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## Associate's Degrees

Students from underrepresented minority groups earn a higher proportion of their S&E degrees at the associate's level than in four-year or graduate programs. In 1996, these students earned about 23 percent of the mathematics and computer science degrees at the associate's level, a far higher percentage than at the bachelor's or advanced levels of higher education. At advanced levels of higher education, the percentage of degrees earned by underrepresented minorities drops off precipitously in fields of NS&E. In contrast, in the social sciences and in non-S&E fields, the drop-off in percentage of degrees earned by underrepresented minorities at advanced levels is not as dramatic. (See figure 4-27 and appendix tables 4-34, 4-35, 4-38, and 4-39.)

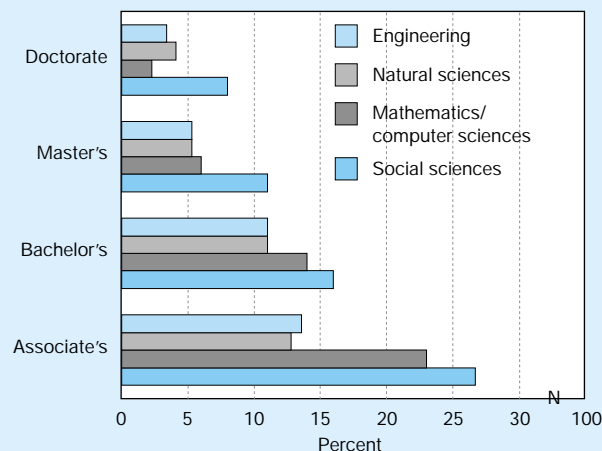
## Bachelor's Degrees

### *Bachelor's Degrees, by Sex*

The United States is among the leading countries in the world in the proportion of undergraduate S&E degrees earned by women. (See appendix table 4-37.) Trends for women show a smoother, steadier increase in their number of earned degrees in the past several decades than for men, but from a lower base. Male trends in earned S&E degrees show strong growth in the 1950s and 1960s, peaks and valleys in the 1970s and 1980s, and declining or level degrees in all fields except the biological sciences in the 1990s. (See appendix table 4-17.) By 1996, women represented 60 percent of the social and behavioral science degrees, 47 percent of natural sciences,

Figure 4-27.

**S&E degrees earned by underrepresented minority students, by level and field: 1996/97**



NOTES: Doctoral-level degrees use 1997 data; all other levels use 1996 data. Natural sciences include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences. Social sciences include psychology, sociology, and other social sciences.

See appendix tables 4-34, 4-35, 4-38, and 4-39.

*Science & Engineering Indicators – 2000*

46 percent of mathematics, 28 percent of computer sciences, and 18 percent of engineering, up considerably from the percentages of 1954. (See text table 4-6.)

Text table 4-6.

**Bachelor's degrees earned by women: 1954 and 1996**

Field	1954			1996		
	Total	Women		Total	Women	
		Number	Percent		Number	Percent
<b>Total, all fields</b> .....	292,880	105,380	0.36	1,179,815	651,815	0.55
<b>Science &amp; engineering</b> .....	117,575	22,743	0.19	384,674	181,333	0.47
Natural sciences .....	17,710	3,890	0.22	98,322	46,556	0.47
Physical sciences .....	8,155	1,194	0.15	15,396	5,702	0.37
Biological & agricultural .....	9,366	2,612	0.28	78,469	39,369	0.50
Earth, atm., & oceanographic ..	189	84	0.44	4,457	1,485	0.33
Math & computer sciences .....	4,090	1,368	0.33	37,621	12,764	0.34
Mathematics .....	4,090	1,368	0.33	13,076	5,992	0.46
Computer sciences .....	NA	NA	NA	24,545	6,772	0.28
Social & behavioral sciences ....	73,446	17,420	0.24	185,617	110,697	0.60
Psychology .....	5,758	2,673	0.46	73,828	53,863	0.73
Social sciences .....	67,688	14,747	0.22	111,789	56,834	0.51
Engineering .....	22,329	65	0.00	63,114	11,316	0.18

NA = not applicable

SOURCES: U.S. Department of Health, Education, and Welfare (HEW), *Statistics of Higher Education: Faculty, Students, and Degrees 1953–54* (Washington, DC: U.S. Government Printing Office, 1956), and appendix table 4-17.

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### **Bachelor's Degrees, by Race/Ethnicity and Citizenship**

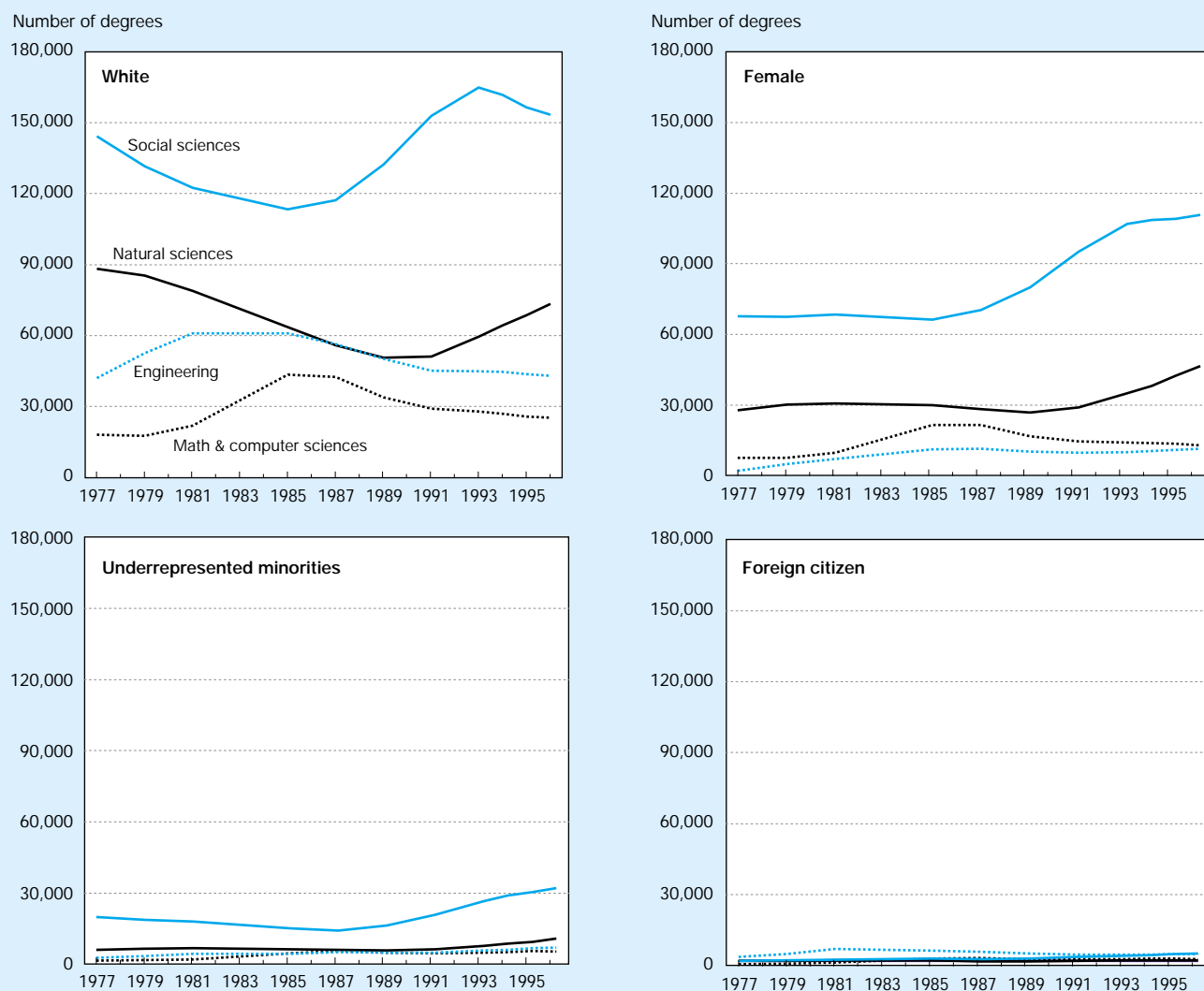
As discussed in “Trends in Earned S&E Degrees,” the number of earned degrees has been increasing in the social and natural sciences and decreasing in engineering, mathematics, and computer sciences. Degrees earned by white and Asian/Pacific Islander students follow this overall pattern.

Trends for subpopulation groups, however, differ somewhat from this overall pattern. The number of degrees earned by the white majority population is declining in every field except the natural sciences. Asian/Pacific Islander students are sharply increasing their earned degrees in the natural and social sciences and leveling off in their number of earned degrees in engineering, mathematics, and computer science fields. De-

grees to underrepresented minorities are increasing in all fields, but from a small base. (See figure 4-28.) From 1989 to 1996, degrees earned by underrepresented minority students increased by 10 percent annually in the social sciences, 9 percent in the natural sciences, 6 percent in engineering, and only 1 percent in mathematics and computer sciences.

Foreign students earn few degrees within U.S. universities at the bachelor's level. During the past two decades, S&E degrees earned by foreign students have remained between 3 and 4 percent of total S&E degrees. They are more concentrated, however, in engineering, mathematics, and computer sciences, representing 7 percent of degrees in these fields. Still, trends in these S&E fields are barely visible on a graph. (See figure 4-28.)

Figure 4-28.  
Bachelor's degrees in S&E fields earned by selected groups



NOTES: Data for 1983 are estimated. Natural sciences include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences. Social sciences include psychology, sociology, and other social sciences.

See appendix tables 4-17 and 4-35.

### Participation Rates, by Sex and Race/Ethnicity

The United States is among the leading nations in the world in providing broad access to higher education but ranks below many major industrialized countries in the proportion of its college-age population with an S&E background. The ratio of bachelor-level degrees to the college-level population was 32 per hundred in 1996, and the ratio of NS&E degrees to the 24-year-old population in the United States was about 5 per hundred in that same year. (See appendix table 4-18.) These national statistics, however, are not applicable to all minority groups within the United States. The ratio of college degrees earned by black and Hispanic groups to their college-age population was 14 to 18 per hundred, and the ratio of NS&E degrees to this college-age population was 2 per hundred. In contrast, Asians/Pacific Islanders have considerably higher than average achievement: the ratio of bachelor's degrees earned by Asians/Pacific Islanders to their college-age population was 40 per hundred, and their ratio of NS&E degrees to their college-age population was 12 per hundred.

Comparing participation rates in 1980 and 1996 shows some progress toward more diversity in higher education in general and S&E in particular. (See text table 4-7.) While low participation rates for blacks and Hispanics changed little throughout the 1980s, they improved considerably in the 1990s, particularly in the social sciences.

### International Comparison of Participation Rates, by Sex

Among countries for which degree data are available by sex, the United Kingdom, Canada, and the United States show relatively high participation rates for both men and women in first university degrees. Among these countries, women in the United Kingdom have the highest participation rate in first university degrees. In 1997, the ratio of first university degrees earned by women to the female 24-year-old population was 38 per hundred, slightly higher than this ratio in the United States and Canada (36 per hundred). Women in the United Kingdom and Canada also show high participation

Text table 4-7.

**Ratio of total bachelor's degrees and S&E bachelor's degrees to the 24-year-old population, by sex and race/ethnicity: 1980 and 1996**

Sex and race/ethnicity	Total 24- year-old population	Total bachelor's degrees	Degree field			Ratio of		
			Natural science degrees	Social science degrees	Engineering degrees	Bachelor's degrees	NS&E degrees	Social science degrees
to 24-year-old population								
1980								
Total .....	4,263,800	946,877	110,468	132,607	63,717	22.2	4.1	3.1
Male .....	2,072,207	474,336	70,102	64,221	56,654	22.9	6.1	3.1
Female .....	2,191,593	472,541	40,366	68,386	7,063	21.6	2.2	3.1
White .....	3,457,800	807,509	100,791	122,519	60,856	23.4	4.7	3.5
Asian/Pacific Islander .....	64,000	18,908	3,467	2,499	3,066	29.5	10.2	3.9
Black .....	545,000	60,779	4,932	16,352	2,449	11.2	1.4	3.0
Hispanic .....	317,200	33,167	3,646	5,748	1,820	10.5	1.7	1.8
American Indian/ Alaskan Native .....	29,800	3,593	337	682	195	12.1	1.8	2.3
1996								
Total .....	3,671,000	1,179,815	135,943	185,617	63,114	32.1	5.4	5.1
Male .....	1,864,000	528,488	76,623	74,920	51,798	28.4	6.9	4.0
Female .....	1,806,000	651,815	59,320	110,697	11,316	36.1	3.9	6.1
White .....	2,472,000	884,128	98,707	153,277	43,098	35.8	5.7	6.2
Asian/Pacific Islander .....	161,000	63,117	13,212	11,020	6,799	39.2	12.4	6.8
Black .....	505,000	89,554	8,670	17,385	3,000	17.7	2.3	3.4
Hispanic .....	500,000	71,015	6,764	13,296	3,731	14.2	2.1	2.7
American Indian/ Alaskan Native .....	33,000	6,813	741	1,324	243	20.6	3.0	4.0

NOTES: The ratios are the number of degrees to the 24-year-old population on a scale of 1 to 100. Population data are for U.S. residents only and exclude members of the armed forces living abroad.

SOURCES: Population data—U.S. Bureau of the Census, *U.S. Population Estimates by Age, Sex, Race, and Hispanic Origin: 1990 to 1997*, PPL-91R (Washington, DC), and previous editions; Degree data—National Center for Education Statistics (NCES), *Earned Degrees and Completion Surveys* (Washington, DC: 1997), unpublished tabulations, and National Science Foundation, Science Resources Studies Division, *Science and Engineering Degrees 1966–96*, NSF 99-330, Author, Susan T. Hill (Arlington, VA: 1999).

rates in NS&E degrees at the bachelor's level. In 1997, the ratio of NS&E degrees earned by women within the United Kingdom to the female 24-year-old population was 6.7 per hundred, about one-half the U.K. male participation rate. The participation rates for men and women in Canada are more similar. (See figure 4-29 and appendix tables 4-36.)

Among Asian countries, women earn first university degrees at a rate similar to or higher than many European countries. However, only in South Korea do women have high participation rates in NS&E degrees. In 1997, the ratio of their earned degrees in these fields to the female 24-year-old population was 4.5 per hundred, higher than the participation rate of women in other Asian countries, Germany, or the United States. (See figure 4-29.) Among all reporting countries, women earn the highest proportion of S&E degrees in the natural and social sciences. (See appendix table 4-37.)

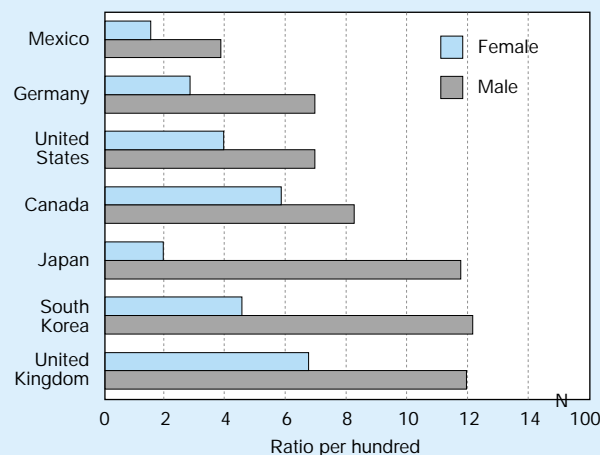
### Graduate Enrollment, by Citizenship, Race/Ethnicity, and Sex

Is the United States educating adequate numbers of bachelor-level S&E majors who are willing and able to pursue advanced degrees in S&E? This issue, voiced by Steelman in 1947, is still of interest to scientific and professional societies and to graduate programs of U.S. universities. The concern has been broadened, however, to ensuring access to women and underrepresented minorities in graduate S&E programs. The following section presents trends in graduate enrollment: strong growth of foreign students and the more modest growth in graduate enrollment of U.S. citizens for the period 1983–93, followed by declining graduate S&E enrollment for both U.S. and foreign citizens. It also provides data on increasing gender equity in graduate S&E fields.

For the period 1983–92, growth in enrollment in U.S. graduate programs in S&E depended on the entry of foreign students, particularly in programs of NS&E. During this period, foreign graduate student enrollment increased at an average annual rate of 5 percent. At the peak of their enrollment in U.S. graduate programs, 1992, foreign students represented one-fourth of all S&E students and an even larger percentage in some fields—one-third of the students in engineering, mathematics, and computer sciences. (See appendix table 4-22.) Recently, increased capacity for graduate S&E education within Asian countries and other career options for Asian students have contributed to the decreasing enrollment of foreign students in U.S. institutions. From 1993 to 1996, foreign graduate student enrollment declined at an average annual rate of 3 percent, with a slight upturn in 1997. Foreign student enrollment should be monitored to see whether the slight increase in enrollment in 1997 is a one-year fluctuation or a reversal of a trend toward fewer foreign graduate students in U.S. higher education.

In contrast, U.S. citizens, including the majority white population and Asians/Pacific Islanders, increased their enrollment in graduate S&E programs at a modest rate of 1 percent for the period 1983–93 and decreased their enrollment 3

Figure 4-29.  
Ratio of NS&E degrees to the college-age population, by country and sex



See appendix table 4-36. Science & Engineering Indicators – 2000

percent annually since then. Underrepresented minorities, however, showed continual steady progress in increasing graduate enrollment. For the period 1983–95, underrepresented minority students increased their enrollment in graduate programs in fields of NS&E at an average annual rate of 6 percent, but from a low base. In the past two years, this growth rate slowed to less than 3 percent. By 1997, underrepresented minorities were 9 percent of graduate enrollment in S&E fields. (See appendix table 4-22.)

The long-term trend of women's increasing proportion of enrollment in all graduate S&E fields has continued during the past two decades. By 1997, women were 38 percent of graduate enrollment in the natural sciences, 19 percent in engineering, and 58 percent in fields of social and behavioral sciences. However, males are not as prevalent in fields of NS&E among underrepresented minority groups; women in these groups have a higher proportion of graduate enrollment compared with the overall average. For example, women are one-third of black graduate students in engineering and more than one-half of the black graduate students in fields of natural sciences. (See text table 4-8.)

### Master's Degrees

#### Master's Degrees, by Sex

Gender equity in S&E degrees at the master's level has improved continually during the past four decades. Such degrees earned by women increased from 1,744 in 1954 to more than 37,000 in 1996, representing 39 percent of all S&E degrees at the master's level in 1996. By far the largest growth has been in the social sciences. Gender equity has been reached in the biological sciences. Modest increases have occurred in engineering, physical sciences, mathematics, and computer sciences.



Text table 4-8.

**Percentage of female enrollment in graduate S&E programs among racial and ethnic groups and foreign students: 1997**

Status/race and ethnicity	Natural sciences	Social sciences	Engineering
<b>Total</b> .....	38	58	19
White .....	38	59	18
Asian/Pacific Islander	42	61	22
Black .....	53	66	32
Hispanic .....	44	61	23
American Indian/ Alaskan Native .....	44	61	24
Foreign students .....	33	42	17

NOTE: Natural sciences include physical, biological, agricultural, earth, atmospheric, and oceanographic sciences, mathematics, and computer sciences. Social sciences include psychology, sociology, and other social sciences.

SOURCE: National Science Foundation, Science Resources Studies Division, *Graduate Students and Postdoctorates in Science and Engineering: Fall 1997*, NSF 99-325, Project Officer, Joan Burrelli (Arlington, VA: 1999).

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By 1996, women earned 58 percent of the master's degrees in the social and behavioral sciences and 49 percent in the biological sciences. However, they earned only 27 percent of computer science degrees and 17 percent of those in engineering. Degrees to males have declined in engineering for the past two years, mainly accounted for by declining engineering enrollment of foreign students. (See appendix table 4-23.)

**Master's Degrees, by Race/Ethnicity**

Minority groups continued to increase their proportion of S&E degrees earned at the master's level. Asians/Pacific Islanders have been increasing the number of master's degrees earned in all fields of S&E for two decades, except for the recent leveling off in engineering fields. (See appendix table 4-38.) The number of master's degrees earned by underrepresented minority graduate students increased modestly in all fields of S&E (especially in the social sciences) from 1990 to the present. (See figure 4-30.) In 1996, underrepresented minorities earned 7.4 percent of the S&E degrees at the master's level. (See appendix table 4-38.)

**Master's Degrees, by Citizenship**

The number of master's degrees earned by U.S. citizens and permanent residents declined or leveled off in engineering, mathematics, and computer science degrees. (See appendix table 4-38.) The number of master's degrees increased only in the natural sciences, particularly in the agricultural and biological sciences. U.S. citizens earned increasing numbers of master's degrees in the biological sciences. Along with engineering, agriculture is a popular major for foreign students in U.S. as well as Japanese universities. Until 1991, foreign students on temporary visas earned 25 percent of the

master's degrees in agricultural science. Chinese foreign students, who shifted to permanent resident status with the 1992 Chinese Student Protection Act, may account for the sharp jump in agricultural degrees recorded between 1992 and 1996 for U.S. citizens and permanent residents (NSF 1999b).

Master's degrees earned by foreign students (on temporary visas), which had increased for two decades, slightly declined in fields of S&E in 1996. Fewer foreign graduate students enrolling in engineering since 1994 account for the fall-off in master's degrees in engineering. (See appendix table 4-38.)

**Doctoral Degrees****Doctoral Degrees, by Sex**

Women have made continual progress toward gender equity in S&E degrees earned at the doctoral level. The proportion of doctoral S&E degrees earned by women increased from 6 percent in 1954 to 33 percent in 1997. The largest gains were made in the social sciences, from approximately 9 percent in 1954 to 51 percent in 1997, and in the natural sciences, from 5 percent in 1954 to one-third in 1997. In engineering, however, doctoral degrees earned by women increased from 0 percent in 1954 to 12 percent in 1997. (See figure 4-31.)

Among countries with disaggregated data on doctoral degrees by sex, women in France have the highest representation in S&E fields. More than 41 percent of the doctoral degrees in the natural sciences are earned by women and almost 23 percent of the engineering degrees. In comparison, women in the United States earn about 34 percent of the S&E degrees at the doctoral level, almost 35 percent of the natural science degrees, and 12 percent of the engineering degrees. (See text table 4-9 and appendix table 4-40.)

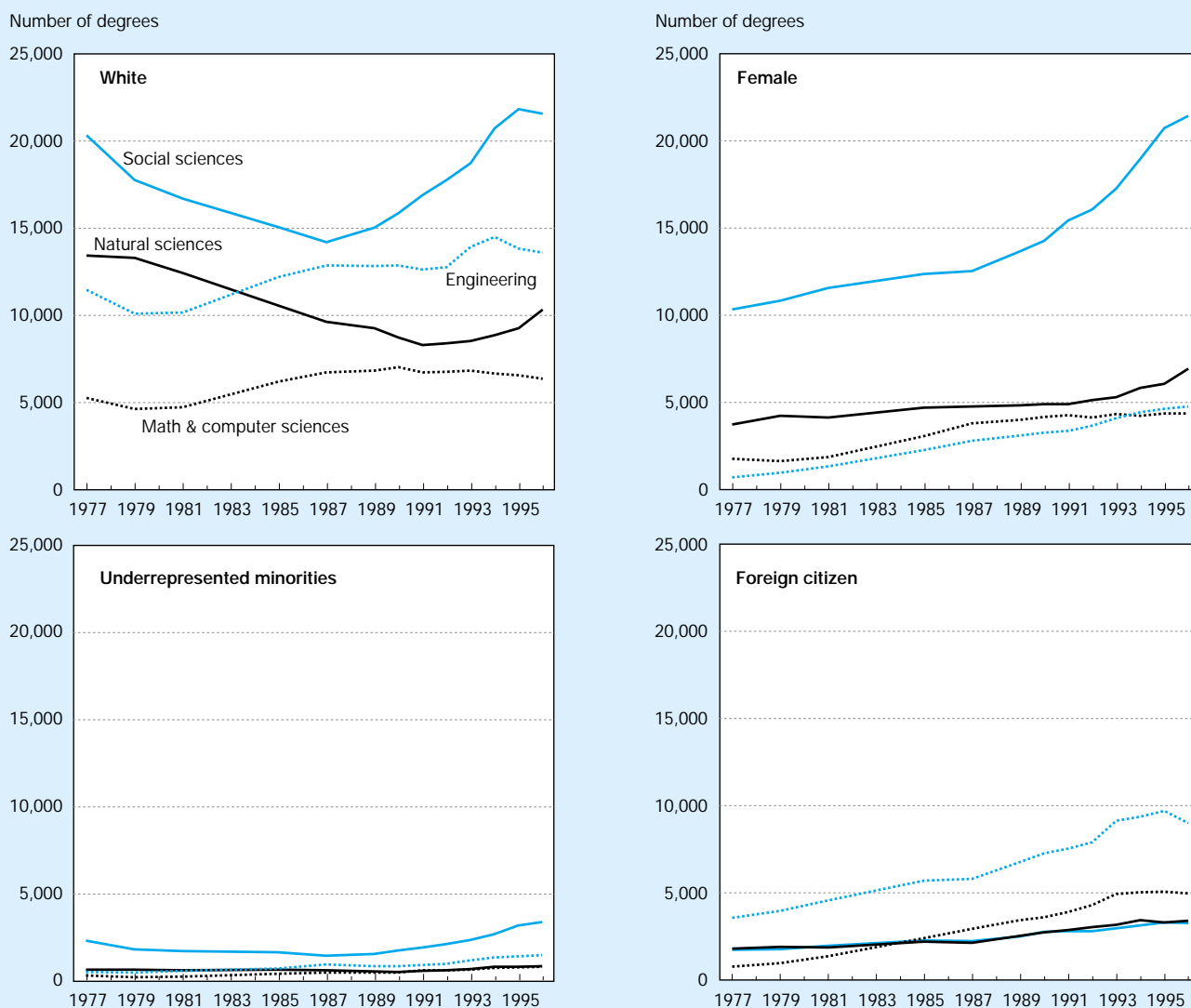
**Doctoral Degrees, by Race/Ethnicity**

In the period 1977–97, the majority white population earned a stable number of degrees in all fields of science, but an increasing number in engineering fields from 1985 until 1995. After 1995, engineering doctoral degrees earned by whites also leveled off. Underrepresented minorities made steady progress in earned doctoral degrees in NS&E from 1985 to 1997, but maintained a low and level number of degrees in the mathematics and computer science fields. Their doctoral degrees are barely visible on a graph that uses the same scale to compare S&E degrees earned by various groups. (See figure 4-32.) In the 1990s, very steep increases in doctoral degrees in all S&E fields among Asians/Pacific Islanders who were citizens and permanent residents mainly reflect the Chinese foreign students on temporary visas shifting to permanent resident status from the 1992 Chinese Student Protection Act.

**Doctoral Degrees, by Citizenship**

Each year from 1986 to 1996, an ever-larger number of foreign students earned S&E doctoral degrees from U.S. universities. The number of such degrees earned by foreign stu-

Figure 4-30.  
Master's degrees in S&E fields earned by selected groups



NOTES: Data are estimated for 1983. Natural sciences include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences. Social sciences include psychology, sociology, and other social sciences.

See appendix tables 4-23 and 4-38.

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dents increased far faster (7.8 percent annually) than those earned by U.S. citizens (2 percent annually). (See appendix table 4-26.) This decade-long trend of increasing number of S&E doctoral degrees earned by foreign students halted in 1997. In that year, the number of degrees earned by foreign doctoral students dropped by 15 percent (see figure 4-33); their enrollment in U.S. graduate S&E programs had declined from 1993 to 1996 and slightly increased in 1997. Students in several Asian countries are becoming somewhat less dependent on U.S. universities for advanced training, particularly in NS&E. (See “International Comparison of Doctoral Degrees in S&E.”)

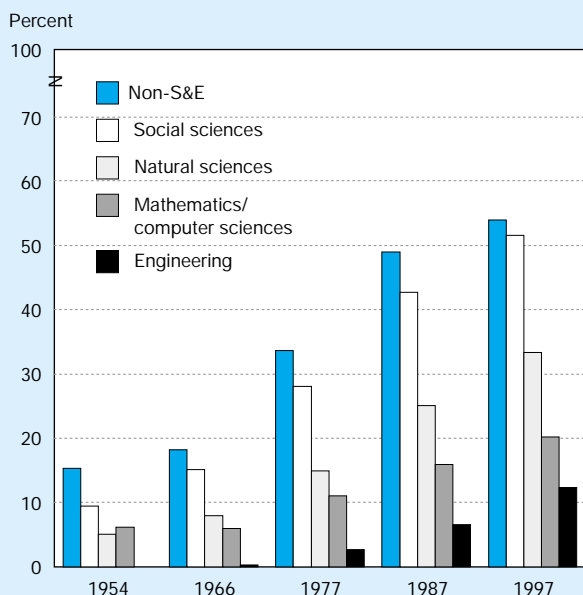
Foreign students earn a larger proportion of degrees at the

doctoral level than in any other degree level. (See figure 4-34.) This concentration increased for a decade, from the mid-1980s to the mid-1990s, peaked in 1996 at 40 percent of all S&E doctoral degrees, and declined in 1997 to 34 percent.

**International Comparison of Foreign Doctoral Recipients.** Like the United States, the United Kingdom, Japan, and France have a large percentage of foreign students in their doctoral S&E programs. In 1997, foreign students earned 45 percent of the doctoral engineering degrees awarded within U.K. universities, 43 percent within Japanese universities, and 49 percent within U.S. universities. In that same year, foreign students earned more than 21 percent of the doctoral degrees in the natural sciences in France, 29 percent in the United



Figure 4-31.  
Proportion of doctoral degrees earned by women in U.S. universities, by field



NOTES: Natural sciences include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences. Social sciences include psychology, sociology, and other social sciences.

SOURCES: U.S. Department of Health, Education, and Welfare, *Statistics of Higher Education: Faculty, Students, and Degrees 1953-54* (Washington, DC: U.S. Government Printing Office); National Science Foundation, Science Resources Studies Division, *Science and Engineering Degrees, 1966-96*. NSF 99-330, Author, Susan T. Hill (Arlington, VA); and appendix table 4-25.

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Kingdom, and 36 percent in the United States. (See text table 4-10.)

**Stay Rates of Foreign Doctoral Recipients.** Historically, about one-half the foreign students who earned S&E doctoral degrees within U.S. universities planned to locate in the United States, and a smaller proportion, about 40 percent, had firm offers to do so. In the 1990s, however, foreign doctoral recipients from Asia, Europe, and North America increasingly planned to stay in the United States and received firm offers to do so. By 1997, 69 percent of foreign doctoral recipients in S&E fields planned to stay in the United States following the completion of their degrees, and 50 percent had accepted firm offers to do so. (See appendix tables 4-42 and 4-43.)

In a recent study of foreign S&E doctoral recipients from 1988 to 1996, 39 percent reported they had firm work or study offers in the United States at the time the survey was conducted. Of the 39 percent who received firm offers to stay, 22 percent were for postdoctoral positions, and 17 percent were for employment offers. The primary work activity identified in these offers from industry was R&D. Industry was more likely to make offers to new foreign Ph.D.s who majored in engineering, the physical sciences, and computer science than to those who majored in other fields (NSF 1998).

The decision of foreign doctoral recipients in S&E fields to remain in the United States has implications for the U.S. economy and the concentration of scientists and engineers in the United States, as well as for the economies of the nations from which these students come. For example, in the 1990s, the number of South Korean and Taiwanese S&E doctoral recipients reporting plans to remain in the United States declined because the economies of South Korea and Taiwan increased those countries' capacities to absorb the majority of

Text table 4-9.  
Percentage of doctoral S&E degrees earned by women, by country: 1997 or most current year

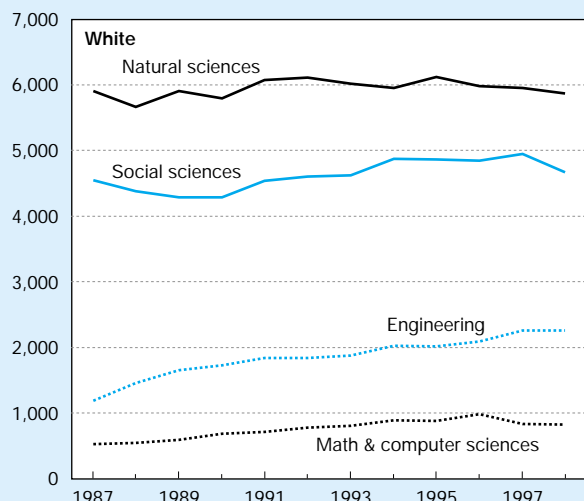
Region/country	All S&E degrees	Degree field				
		Natural sciences	Math/ computer sciences	Agricultural sciences	Social sciences	Engineering
Asia						
Japan .....	10.4	10.2	7.7	15.7	23.4	5.5
South Korea .....	10.5	18.8	31.0	14.0	13.4	3.0
Taiwan .....	10.8	15.2	14.3	38.5	25.8	2.3
Europe						
France .....	35.0	41.4	22.9	51.2	36.3	22.5
Germany .....	22.5	25.9	17.1	35.5	27.5	8.3
United Kingdom .....	27.7	34.4	18.4	31.6	32.7	13.4
North America						
Canada .....	26.7	22.4	14.2	36.9	50.2	9.1
Mexico .....	33.8	32.7	18.2	27.1	43.3	18.5
United States .....	33.7	34.9	20.2	26.4	51.6	12.3

See appendix table 4-40.

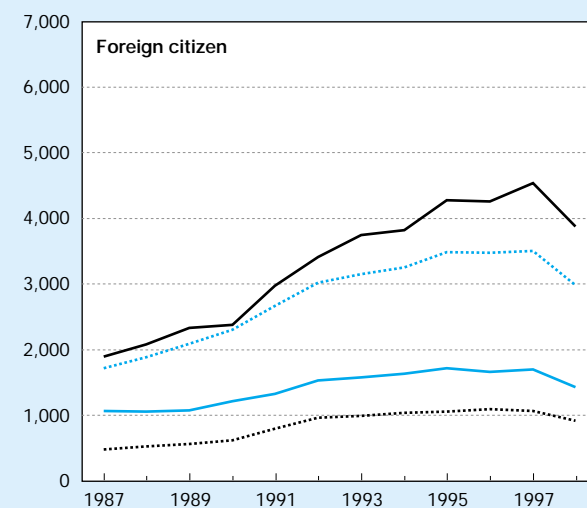
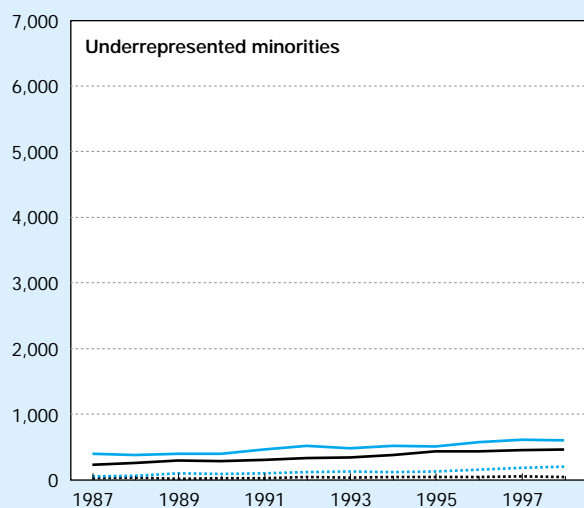
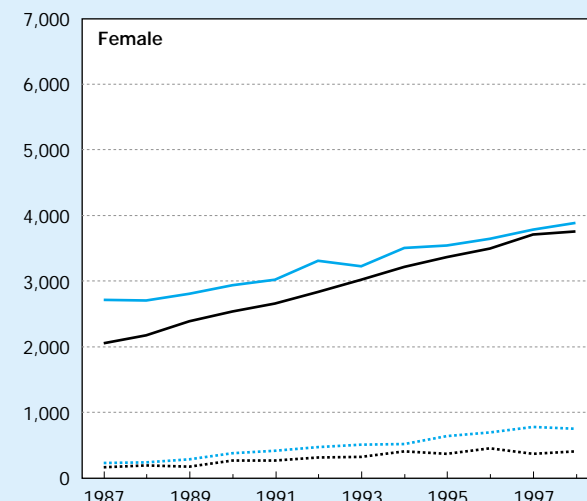
Science & Engineering Indicators – 2000

Figure 4-32.  
Doctoral degrees in S&E fields earned by selected groups

Number of degrees



Number of degrees



NOTES: Natural sciences include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences. Social sciences include psychology, sociology, and other social sciences.

See appendix tables 4-25, 4-26, and 4-39.

Science & Engineering Indicators – 2000

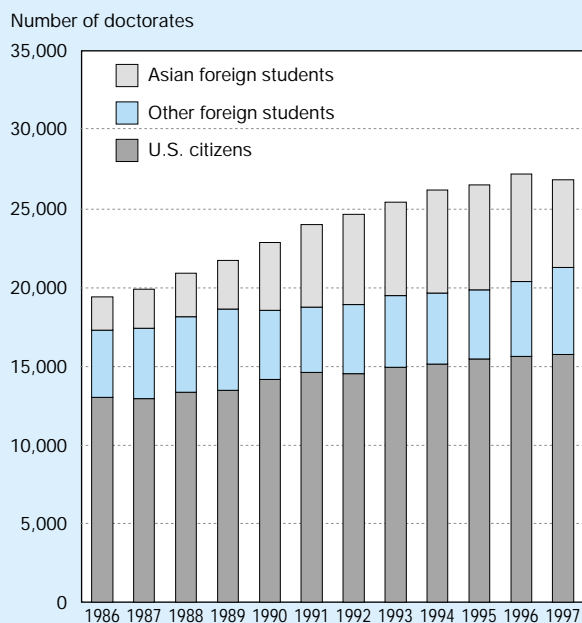
the U.S.-trained doctoral scientists and engineers. In 1997, however, a larger percentage of foreign students from all Asian countries sought to remain in the United States, possibly reflecting the Asian economic crisis. However, since the S&E doctoral degrees earned by foreign students dropped 15 percent in 1997 (see appendix table 4-26), the numbers actually staying also decreased by 8 percent in that year. (See appendix table 4-42; for the decrease in doctoral recipients from the major countries of origin in North America, Europe, and Asia and the decreasing numbers planning to stay, see figure 4-35 and appendix table 4-43.)

A recent study of foreign doctoral recipients working and

earning wages in the United States (Finn 1999) shows that about 53 percent of the foreign students who earned S&E doctorates in 1992 and 1993 were working in the United States in 1997. The stay rates are higher in physical and life sciences and in engineering and lower in the social sciences. For example, 61 percent of the foreign students who earned a doctorate in computer sciences in 1992 and 1993 were employed in the United States four to five years later, while only 32 percent of those in the social sciences were employed in the United States. (See chapter 3.)

Stay rates differ more by country of origin than by discipline, however. The large majority of 1992 and 1993 engineering doc-

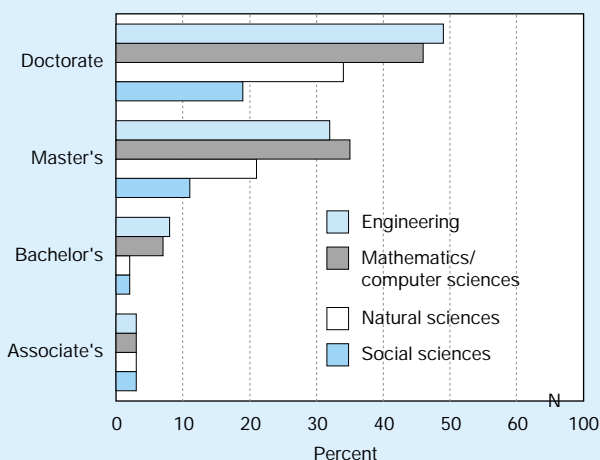
Figure 4-33.  
U.S. doctoral S&E degrees earned by U.S. and foreign citizens: 1986–97



See appendix table 4-41 for Asian countries included.

Science & Engineering Indicators – 2000

Figure 4-34.  
S&E degrees earned by foreign students, by level and field



NOTES: Associate's, bachelor's, and master's degree data are for 1996; doctoral degree data are for 1997. Natural sciences include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences. Social sciences include psychology, sociology, and other social sciences.

See appendix tables 4-34, 4-35, 4-38, and 4-39.

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Text table 4-10.

Percentage of NS&E doctoral degrees earned by foreign students in selected countries: 1997

Country	Natural sciences <sup>1</sup>	Engineering
United States .....	36.2	49.4
France .....	21.1	31.5
Germany .....	6.9	12.0
Japan <sup>2</sup> .....	25.8	42.6
United Kingdom .....	28.9	44.7

<sup>1</sup>Natural sciences include mathematics, computer sciences, and agricultural sciences.

<sup>2</sup>Percentage of NS&E doctoral degrees earned by foreign students within Japanese universities only; not those earned within industry.

SOURCES: **France**—Ministère de l'Éducation National, de la Recherche, et de la Technologie, *Rapport sur les Études Doctorales* (Paris: 1998); **Germany**—Statistisches Bundesamt, *Prüfungen an Hochschulen* (Wiesbaden: 1998); **Japan**—Ministry of Education, Science, and Culture (Monbusho), *Monbusho Survey of Education* (Tokyo: annual series); **United Kingdom**—Higher Education Statistical Agency, *Students in Higher Education Institutions, 97/98* (Cheltenham: 1999); **United States**—National Science Foundation, Science Resources Studies Division, *Science and Engineering Doctorate Awards: 1997*, NSF 99-323 (Arlington, VA: 1999).

Science & Engineering Indicators – 2000

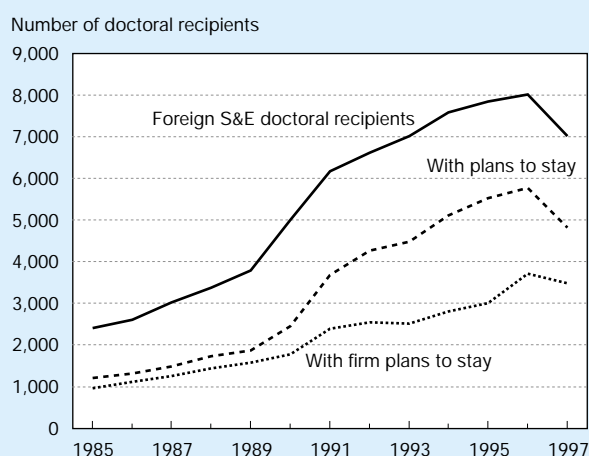
toral recipients from India (90 percent) and China (97 percent) were working in the United States in 1997. In contrast, only 8 percent of South Koreans who completed engineering doctorates from U.S. universities in 1992 and 1993 were working in the United States in 1997. (See appendix table 4-44.)

Stay rates for foreign students are not static. Because China is now the main country of origin of foreign S&E doctoral recipients in the United States, the trend toward increasing stay rates in the 1990s should be followed to see whether it is temporary. Should China succeed in implementing economic reforms that rely heavily on scientific and technological progress, the demand for high-level specialized personnel and the number of new Ph.D.s returning to China may increase substantially.

## Postdoctoral Appointments

Postdoctoral researchers play an important role in the dissemination of S&E knowledge and new techniques, and Japan and European countries are introducing more postdoctoral researchers as a way to improve the vitality of their science (AAAS 1999 and Frijdal and Bartelse 1999.) By 1997, postdoctoral researchers in the United States numbered more than 38,000. Postdoctoral appointments for research are made primarily in fields of science and medicine, rather than in engineering. In 1997, postdoctorates in engineering made up only 8 percent of the 38,000 postdoctorates in all surveyed fields. In that year, foreign researchers performed a slight majority (53 percent) of S&E postdoctoral research. These percentages differ, however, in fields of science versus engineering. Postdoctoral appoint-

Figure 4-35.  
Foreign S&E doctoral recipients (from North America, Europe, and Asia) with plans to stay in the United States: 1985–97



See appendix table 4-43 for countries included in each region.

Science & Engineering Indicators – 2000

ments in fields of science are filled by approximately equal numbers of U.S. and foreign researchers; engineering postdoctorates are filled more often by foreign researchers (63 percent). (See appendix table 4-45 and chapter 3 for further discussion of postdoctoral appointments.)

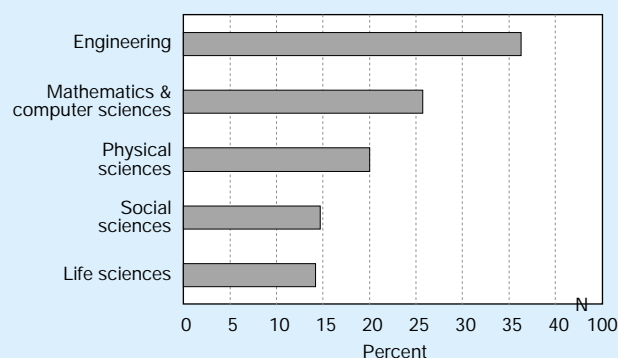
## International Dimension of U.S. Higher Education Faculty

One indicator of mobility of S&E personnel in the world is the proportion of foreign-born faculty in U.S. higher education. The United States has been a magnet for trained scientists and engineers because of a well-developed economy able to absorb high-level personnel. (See chapter 3 for the proportion of immigrant scientists and engineers in the overall U.S. labor force.)

The U.S. university system has been able to employ considerable numbers of foreign-born scientists and engineers.<sup>20</sup> In 1997, of the 225,000 faculty teaching S&E in four-year institutions, 45,000 are foreign-born scientists and engineers. Foreign-born faculty in U.S. higher education represent more than 36 percent of the engineering professors and more than one-quarter of the mathematics and computer science teachers. (See figure 4-36.) These faculty are mainly from Asian and European countries, with the largest numbers coming from India, China, and England. (See text table 4-11.) The vast majority of these faculty earned their doctoral education in

<sup>20</sup>These data are based on the integrated data files of the NSF SESTAT system, a system of data about the S&E workforce.

Figure 4-36.  
Foreign-born S&E faculty in U.S. higher education, by field: 1997



See appendix table 4-46. Science & Engineering Indicators – 2000

Text table 4-11.  
Major countries of origin of foreign-born S&E faculty members in U.S. universities: 1997

Place of origin	Number	Percentage
<b>Total S&amp;E faculty</b> .....	224,707	100.0
U.S.-born .....	179,698	80.0
Foreign-born .....	45,009	20.0
<b>Total S&amp;E faculty from major countries of origin</b> .....	21,545	9.6
India .....	6,876	3.1
China .....	4,830	2.1
United Kingdom .....	3,426	1.5
Taiwan .....	1,820	0.8
Germany .....	1,309	0.6
South Korea .....	1,218	0.5
Greece .....	1,044	0.5
Japan .....	1,022	0.5
Other .....	23,464	10.4

NOTE: Data include scientists and engineers whose first job is in S&E postsecondary teaching at four-year colleges and universities in the United States; it excludes scientists and engineers who may teach as a secondary job.

See appendix table 4-48. Science & Engineering Indicators – 2000

U.S. universities. However, those who received their doctoral education outside the United States and began teaching in U.S. universities after 1993 are not captured in the NSF's SESTAT database. Therefore, the percentages of foreign-born faculty are underestimations, particularly from the countries of the former Soviet Union. Faculty from these countries are most likely to have obtained their doctoral degrees before immigrating to the United States and may have come after 1993. (See appendix tables 4-46, 4-47, and 4-48.)